Patent

In the United States Patent and Trademark Office
Board of Patent Appeals and Interferences

In the Application of:

Che-Hsiung Hsu et al. CASE NO.: **UC0420 US NA**

APPLICATION NO.: **10/814,917** GROUP ART UNIT: **1796**

FILED: **March 31, 2004** EXAMINER: **Woodward, Ana L.**

CONFIRMATION NO.: **6333**

FOR: **Aqueous Electrically Doped Conductive Polymers and Polymeric Acid Colloids**

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Appeal Brief
37 C.F.R. § 41.37

1. Real Party in Interest. The real party in interest is E. I. du Pont de Nemours and Company, 1007 Market Street, Wilmington, Delaware 19898 ("DuPont") by virtue of assignments by the inventors of assignors' entire right, title and interest as follows: (1) assignment from Che-Hsiung Hsu to DuPont recorded at Reel/Frame 014832/0514 on July 9, 2004 and (2) assignment from Che-Hsiung Hsu to DuPont and from Chi Zhang to DuPont Displays, Inc. recorded at Reel/Frame 016093/0454 on June 3, 2005. DuPont Displays, Inc. is a wholly owned subsidiary of DuPont. Moreover, Applicants filed a Request to Correct Inventorship under 37 C.F.R. § 1.48(a) with supporting documents on May 16, 2005, requesting the addition of co-inventor Chi Zhang.

2. Related Appeals and Interferences. Appellant, assignee and undersigned legal counsel are not aware of any prior and pending appeals, interferences, or judicial proceedings which may be related to, directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

3. Status of Claims. Claims 1-6, 9 and 13-21 are pending in the application. Claims 1-4, 6, 9 and 13-21 stand as finally rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 7,071,289 ("Sotzing"); claim 5 was objected to as being dependent upon a rejected base claim but would be allowable if written in independent form including all the limitations of the base claim and any intervening claims. The final rejection of claims 1-4, 6, 9 and 13-21 is being appealed herein.

4. Status of Amendments. Applicant's Response, 37 C.F.R. § 1.116 which contained no new amendments to the claims was entered and considered. The final rejection of claims 1-4, 6, 9 and 13-21 was maintained for reasons previously of record.

5. Summary of Claimed Subject Matter.

Claim 1 is a composition claim. The composition comprises **an aqueous dispersion** of at least one **conductive polymer** selected from a polythiophene, a polypyrrole, a polyaniline, and combinations thereof, doped with at least one **non-polymeric acid anion** and at least one **colloid forming polymeric acid** which is a **fluorinated** polymeric **sulfonic** acid.

The term "dispersion" is defined in the specification in the paragraph bridging pages 2 and 3 as a continuous liquid medium containing a suspension of minute particles where the continuous liquid medium comprises an aqueous liquid. The term "aqueous" refers to a liquid that has a significant portion of water (page 3, lines 2-3).

Conductive polymers are homopolymers or copolymers (page 3, lines 11-15) of polythiophenes having Formula I (page 3, line 16 to page 4, line 3; polypyrroles of Formula II (page 5, line 10 to page 6, line 2) and polyanilines of Formula III or IV (page 6, line 32 to page 7, line 22). The conductive polymers are doped with one or more different non-polymeric acid anions (page 3, lines 13-15). The term "doped" refers to the formation of an ion pair where the negative charge on the dopant balances the positive charge on a conductive polymer. Page 3, lines 8-10. The non-polymeric organic acid anion dopants are derived from acids which are water soluble or dispersible. The anionic charge balances the positive charge on the conductive polymer. Page 7, lines 23-26. Examples of suitable acids are set forth by way of illustration on page 8, lines 3-9.

The composition also comprises a colloid-forming fluorinated polymeric sulfonic acid. The term "colloid" refers to minute, nanometer scale particles suspended in the continuous

medium (page 3, lines 3-5), and "colloid-forming" refers to substances that are not water-soluble and form minute particles when dispersed in aqueous solution. Page 3, lines 6-8, page 8, lines 10-13 and page 8, lines 23-24 (the polymeric sulfonic acid is fluorinated). See also page 8, lines 10-12, "Colloid-forming polymeric acids contemplated for use in the new compositions are insoluble in water, and form colloids when dispersed into an aqueous medium."

Claim 2 specifies that the pH range of the composition of claim 1 is between 1 and 8. Please see page 14, lines 33-38, Example 4, page 27, and Table 1, page 28.

Claim 3 specifies that the conductive polymer is a polythiophene of Formula I. Page 3, line 16 to page 4, line 3.

Claim 4 specifies that the conductive polymer is a polypyrrole of Formula II. Page 5, line 10 to page 6, line 2.

Claim 9 recites that the polymeric sulfonic acid is perfluorinated. Page 8, line 33; page 9, line 35 to page 10, line 5.

With respect to the summaries of subject matter of claims 13-17 and 21, the terms "layer" or "film" which are synonymous are defined at page 15, line 33 to page 16, line 4, and further discussion on pages 16 and 17.

Claim 13 is directed to a conductive or semiconductive layer deposited from a composition of claim 1. Page 2, lines 11-12; page 15, lines 16-19.

Claim 14 addresses a buffer layer deposited from a composition of claim 1. Page 2, lines 13-14; page 15, lines 24-32.

Claim 15 depends from claim 14, and recites that the colloid-forming polymeric acid is perfluoroethylenesulfonic acid. Page 10, lines 12-24; page 11, lines 27-29; page 16, lines 14-20; and page 26, lines 1-3.

Claim 16 is an independent claim encompassing a **buffer layer** comprising an electrically conductive **polypyrrole/non-polymeric acid dopant** and **polymeric perfluoroethylenesulfonic acid** where the aqueous dispersion has a **pH greater than 2** and a weight ration of polymeric perfluoroethylenesulfonic acid : polypyrrole + non-polymeric acid anion of greater than 1. The defined terms have been discussed above with citations to their definitions and applications in the present disclosure. See Example 3, disclosing weight ratio of colloid-forming acid : polymer + dopant of 2.11 : 1.0 (page 27, lines 13-15). The perfluoroethylenesulfonic acid is Nafion® and

the polypyrrole/non-polymeric acid anion is an Aldrich product (page 25, lines 10-12). Its dependent claim, Claim 21, recites a device having at least one **buffer layer** of claim 16.

Claim 17 addresses an electronic device having at least one layer comprising at least one composition of claim 1. Page 2, lines 15-16; and page 17, lines 17-19.

Claim 18 depends from claim 17 and recites devices that may benefit from having a layer made from the new composition. Page 17, lines 17-32.

Claims 19 and 20 set forth methods for making a composition of claim 1. Claim 19 provides three alternative methods for forming the composition: (a) dispersing doped conductive polymer solids in an aqueous dispersion of colloid-forming polymeric acid; (b) dispersing colloid-forming polymeric acid solids in a aqueous dispersion of doped conductive polymer; and (c) combining an aqueous dispersion of doped conductive polymer with an aqueous dispersion of colloid-forming polymeric acid. Claim 20 presents a method of forming the composition by doping the conductive polymer and combining the doped conductive polymer with the colloid-forming polymeric acid. See page 12, lines 13-22, Comparative Example 1, page 25, and Example 1, pages 25-26; and Example 3, page 27.

6. Grounds of Rejection to be Reviewed on Appeal:

Whether claims 1-4, 6, 9 and 13-21 are unpatentable

Under 35 U.S.C. § 103(a) over Sotzing.

7. Argument: Claims 1-4, 6, 9 and 13-21 are patentable over Sotzing.

Sotzing's Disclosure

Sotzing relates to polymers and copolymers comprising repeating units of thieno[3,4-b]thiophene. (Abstract) Sotzing discloses that the polymers may be doped with conventional p-dopants or n-dopants (Col. 3, lines 33-35). Alternatively, the polymer may be reacted with an oxidant in the presence of a polyanion. Col. 3, lines 36-52. See also Example 2, describing the aqueous synthesis of poly(thienothiophene) with polyanion poly(styrenesulfonic acid). p-Doped compositions are taught to be especially useful as the anode and hole injection injection layers, while n-doped compositions are said to be useful in the "light harvesting layers". Col. 7, lines 64-67. The polymers are made by aqueous phase polymerization of monomers in the presence of a polyanion and a chemical oxidant (see column 8, lines 60-67) or by electrochemical oxidation (see column 9, lines 62-66). The only disclosure of dopant mixtures in Sotzing is of a

mineral acid and an organic acid (see column 7, lines 28-31).

Prima Facie Obviousness Has Not Been Established

To summarize claim 1, this claim recites an aqueous dispersion of 1) certain conductive polymers doped with non-polymeric organic acid anion(s) **and** 2) colloid-forming polymeric acid(s) which are perfluorinated sulfonic acid polymers.

The MPEP states: "The examiner bears the initial burden of factually supporting any *prima facie* conclusion of obviousness." *Id.* at §2142 ("To establish a prima facie case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. … Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations."). The Office Action has failed to factually support the rejection.

For example, the Office Action states "[i]n essence, the disclosure of the reference differs from the present claims in not expressly exemplifying an embodiment comprising a thieno[3,4-b]thiophene polymer in combination with a non-polymeric organic acid dopant and Nafion. It is maintained that it would have been obvious to one having ordinary skill in the art to have employed an aqueous dispersion comprising a thieno[3,4-b]thiophene polymer in combination with a non-polymeric organic acid dopant and Nafion, for their expected additive effect, as per such being within the general scope of the reference disclosure." *Final Office Action* at page 2, last paragraph. The MPEP reminds Examiners that "[d]istilling an invention down to the 'gist' or 'thrust' of an invention disregards the requirement of analyzing the subject matter 'as a whole.'" *Id.* at §2141.02. The risk to the patent system is that the resulting analysis then becomes of a conclusory nature.

Applicant submits that the Office Action's statement [*loc. cit.*] that "it would have been obvious … to have employed [a thienothiophene polymer, a non-polymeric acid dopant, and Nafion], for their expected additive effect" is precisely the type of analysis that the Patent Office seeks to avoid. What evidence has the Examiner provided that the reference suggests this combination and teaches or fairly suggests "expected additive effects"? Or, if it is alleged to be general knowledge, what evidence has the Examiner provided that a mixture has any more additive effect than merely increasing the amount of a single dopant?

The Board has recently held in *Ex parte Whalen et al.*, Appeal 2007-4423, Application 10/281,142, Technology Center 1600, July 23, 2008, that an invention composed of several elements is not proved obvious merely by demonstrating that each of the several elements was, independently, known in the prior art. Page 15. The Board also stated, in citing from the U.S. Supreme Court decision in *KSR Int'l Co. v. Teleflex Inc.,* 127 S.Ct. 1727, 1741 (2007), that "it can be important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the [prior art] elements in the way that the claimed invention does. To facilitate review, this analysis should be made explicit." *Id.* The Board went on to hold, page 16, that it must be shown that those of ordinary skill in the art would have had some apparent reason to modify the known composition in a way that would result in the claimed composition. Failure to do so persuasively fails to make out a *prima facie* case of obviousness. *Id.*

Under the circumstances, the combination of a doped conductive polymer with a colloid-forming fluorinated polymeric sulfonic acid could improve the situation, make it worse, or not change things at all. The Examiner has provided no *evidence* that one outcome is any more likely than another. The MPEP states that "[i]t is never appropriate to rely solely on common knowledge in the art without evidentiary support in the record as the principal evidence upon which a rejection was based." MPEP §2144.03. Similarly, absent Applicant's discovery that the presently claimed compositions are desirable, the Examiner would have no direction to arrive at the proposed modification. *See In Re Kahn,* 441 F.3d 977, 986 (Fed. Cir. 2006) ("The use of hindsight is inferred if an explanation is not provided of the motivation, or the suggestion or teaching, that would have led a skilled artisan at the time of the invention to the claimed combination as a whole."). Accordingly, the rejection is improper as lacking suggestion and motivation.

The rejection is also improper as failing to teach or suggest all claim limitations. Each rejected claim requires a showing of *why* it is obvious. A few examples are discussed below.

Claim 1 requires "an aqueous dispersion of at least one conductive polymer and at least one colloid-forming polymeric acid, wherein the electrically conducting polymer is doped with at least one non-polymeric organic acid anion." Applicant submits that the failure of the Examiner to explain with reasonable specificity the suggestion or motivation to arrive at this limitation procedurally fails to establish a *prima facie* case of obviousness. Claim 1 also requires

that the polymeric acid be a fluorinated polymeric sulfonic acid. The polyanion taught by Sotzing, poly(styrenesulfonic acid) is water soluble, and therefore not colloid-forming.

Applicants respectfully submit that there are no "expected" additive effects based on the teaching of Sotzing. It is Applicants who have discovered the benefits of the compositions recited in Claim 1, and its dependent claims.

Sotzing Does Not Teach or Fairly Suggest the Claimed Compositions

Sotzing teaches that polymers formed from thiophene and substituted thiophene which possess relatively low band gaps (E_g) demonstrate measurable electrical conductivity, and may be referred to as "intrinsically conducting polymers". Sotzing teaches that the band gap or E_g exhibited by a given polymer depends upon a variety of factors including the structure of the monomer making up the polymer. Col. 1, lines 18-31. Sotzing presents examples of poly(thiophenes) with E_g varying between eV and 0.85 eV. Sotzing further teaches that modifying the polymers to maintain low band gap but increase solubility in a particular organic solvent may be achieved by: addition of side chains that are soluble in a particular organic solvent, modifying the conjugated backbone by including flexible spacer groups, and using charge compensating dopants. Col. 1, lines 32-43.

Sotzing is directed to compositions of matter formed from polymerized units of thieno[3,4-b]thiophene and, more particularly, to polymers comprising repeating units of the thienothiophene. Col. 2, lines 3-6. The preferred substituted thienothiophenes of the reference to be incorporated into polymers to form a copolymer have the formula:

wherein R=C_1 to C_{25} primary, secondary or tertiary alkyl group, phenyl, substituted phenyl, cyclohexyl, naphthalenic, hydroxyl, alkyl ether, carboxylic acid, carboxylic ester and a sulfonic acid

Col. 2, lines 50-67. In Sotzing's definitions, "polymer" is defined as "a composition of matter having at least five polymerized units of thieno[3,4-b]thiophene. Thus the term, polymer, includes copolymers and oligomers having at least five polymerized units of thieno[3,4-b]thiophene." Col. 4, lines 1-5. Sotzing's preferred embodiment is a homopolymer referred to as poly(thieno[3,4-b]thiophene). Col. 5, lines 30-35. Sotzing teaches that the polymers disclosed in the reference, typically of intrinsically conducting polymers in general, are not soluble in water. Col. 1, lines 32-34. Therefore, a polymeric acid anion that is soluble in water can, per Sotzing, be used with his thienothiophenes because the conducting polymer is not soluble in water and will remain in dispersion. Col. 1, lines 53-62; see also Col. 6, lines 48-51 ("The compositions of matter of this invention can be utilized as dispersions by combining a desired polymer (including copolymers and oligomers) with water, a mixture of a water-miscible organic solvent or an organic solvent.") The dispersed films may be dried by evaporation or heating.

Sotzing lists suitable p-dopants (protic acids, generally preferred) and n-dopants (which are basic, and include Na, K, Li and Ca, and also, I_2, PF_6, SbF_6 and $FeCl_3$). See Col. 7, lines 13-36. Sotzing also lists polyanions, including "nafion" (*sic.*) in Col. 9, lines 27-38. The molecular weights of the acids supplying the polyanions are preferably in the range of from 1,000 to 500,000. The list of suitable polyanions includes water-soluble polymeric acids (e.g., polystyrene sulfonic acid).

Applicants respectfully submit that Sotzing does not teach or fairly suggest the presence of a colloid-forming polymeric acid and a non-polymer acid anion dopant, nor does the reference teach or fairly suggest the polythiophenes of claim 3 and its dependent claims. The Office Action alleges that Sotzing's thieno[3,4-b]thiophene fulfills the present claim requirement of a polythiophene. Applicants respectfully traverse this assertion. Sotzing requires at least five of these units to constitute a polymer, and prefers the homopolymer of poly(thieno[3,4-b]thiophene) while teaching, as noted, that structure of the monomer is a key factor in determing a desirably low band gap, E_g. In addition, Sotzing requires a p-dopant in addition to the polyanion acid, which is not required in the present claims. Claim 1 specifies an organic acid polymer, whereas Sotzing teaches protic acids for the p-dopant. These and other distinctions patentably define over Sotzing. Alternatively stated, Sotzing presents a *unitary composition*: either a polymer : dopant ion pair or a polymer : polyacid ion pair. The present claims present a *binary*

composition: polymer : dopant + colloid-forming fluorinated polymeric sulfonic acid.

Accordingly, Applicants respectfully submit that the present claims are not obvious over the Sotzing and that this rejection should be withdrawn.

Conclusion

Applicants respectfully ask the Board to remand the application for further prosecution in light of the decision on the merits reached by the BPAI.

Respectfully submitted,

/John H. Lamming/

John H. Lamming
Registration No. 34,857
Corporate Counsel
E. I. du Pont de Nemours and Company
Telephone : 302-992-5877

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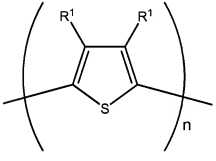
8. Claims Appendix

1. A composition comprising an aqueous dispersion of at least one conductive polymer and at least one colloid-forming polymeric acid, wherein the electrically conducting polymer is doped with at least one non-polymeric organic acid anion, and wherein the conductive polymer is selected from a polythiophene, a polypyrrole, a polyaniline, and combinations thereof, wherein said colloid-forming polymeric acid comprises a fluorinated polymeric sulfonic acid.

2. A composition according to claim 1, wherein pH of the dispersion is between 1 and 8.

3. A composition according to Claim 1, wherein the conductive polymer is a polythiophene comprising Formula I:



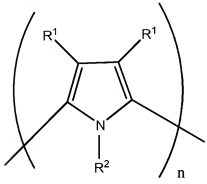
(I)

wherein:

R^1 is independently selected so as to be the same or different at each occurrence and is selected from hydrogen, alkyl, alkenyl, alkoxy, alkanoyl, alkythio, aryloxy, alkylthioalkyl, alkylaryl, arylalkyl, amino, alkylamino, dialkylamino, aryl, alkylsulfinyl, alkoxyalkyl, alkylsulfonyl, arylthio, arylsulfinyl, alkoxycarbonyl, arylsulfonyl, acrylic acid, phosphoric acid, phosphonic acid, halogen, nitro, cyano, hydroxyl, epoxy, silane, siloxane, alcohol, benzyl, carboxylate, ether, ether carboxylate, amidosulfonate, ether sulfonate, and urethane; or both R^1 groups together may form an alkylene or alkenylene chain completing a 3, 4, 5, 6, or 7-membered aromatic or alicyclic ring, which ring may optionally include one or more divalent nitrogen, sulfur or oxygen atoms, and

n is at least about 4.

4. A composition according to Claim 1, wherein the conductive polymer is a polypyrrole comprising Formula II:



(II)

wherein:

n is at least about 4;

R^1 is independently selected so as to be the same or different at each occurrence and is selected from hydrogen, alkyl, alkenyl, alkoxy, alkanoyl, alkythio, aryloxy, alkylthioalkyl, alkylaryl, arylalkyl, amino, alkylamino, dialkylamino, aryl, alkylsulfinyl, alkoxyalkyl, alkylsulfonyl, arylthio, arylsulfinyl, alkoxycarbonyl, arylsulfonyl, acrylic acid, phosphoric acid, phosphonic acid, halogen, nitro, cyano, hydroxyl, epoxy, silane, siloxane, alcohol, benzyl, carboxylate, ether, ether carboxylate, amidosulfonate, ether sulfonate, and urethane; or both R^1 groups together may form an alkylene or alkenylene chain completing a 3, 4, 5, 6, or 7-membered aromatic or alicyclic ring, which ring may optionally include one or more divalent nitrogen, sulfur or oxygen atoms; and R^2 is independently selected so as to be the same or different at each occurrence and is selected from hydrogen, alkyl, alkenyl, aryl, alkanoyl, alkylthioalkyl, alkylaryl, arylalkyl, amino, epoxy, silane, siloxane, alcohol, benzyl, carboxylate, ether, ether carboxylate, amidosulfonate, ether sulfonate, and urethane.

6. A composition according to Claim 1, wherein the non-polymeric organic acid anion is selected from acetate, p-toluenesulfonate, camphorsulfonate, p-dodecylbenzenesulfonate, methanesulfonate, trifluoromethanesulfonate, and mixtures thereof.

9. A composition according to Claim 1, wherein said polymeric sulfonic acid is perfluorinated.

13. An electrically conductive or semiconductive layer deposited from a composition according to Claim 1.

14. A buffer layer deposited from a composition according to Claim 1.

15.) A buffer layer according to claim 14 wherein said colloid-forming polymeric acid is perfluoroethylenesulfonic acid.

16. A buffer layer made from an aqueous dispersion comprising electrically conductive polypyrrole/non-polymeric acid dopant and polymeric perfluroethylenesulfonic acid, wherein the aqueous dispersion has a pH greater than 2 and a weight ratio of polymeric perfluroethylenesulfonic acid to polypyrrole +non-polymeric acid anion greater than 1.

17. An electronic device or other applications comprising at least one layer comprising at least one composition of Claim 1.

18. A device according to Claim 17, wherein the device or application is selected from devices that convert electrical energy into radiation, devices that detect signals through electronics processes, that convert radiation into electrical energy, devices having at least one electronic component, memory storage devices, energy storage devices, antistatic films, biosensor devices, electrochromic devices, and electromagnetic shielding applications.

19. A method of making the composition of Claim 1, the method comprising one of the following:

(a) dispersing doped conductive polymer solids in an aqueous dispersion of colloid-forming polymeric acid;

(b) dispersing colloid-forming polymeric acid solids in an aqueous dispersion of doped conductive polymer; and

(c) combining an aqueous dispersion of doped conductive polymer with an aqueous dispersion of colloid-forming polymeric acid.

20. A method of making the composition of Claim 1 comprising,

doping the at least one conductive polymer with the at least one non-polymeric organic acid anion; and

then combining the doped conductive polymer with the at least one colloid-forming polymeric acid.

21. An electronic device comprising at least one buffer layer of Claim 16.

9. Evidence Appendix

None.

10. Related Proceedings Appendix.

None.